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Maintenance Management of U.S. Army Railroad Networks— The RAILER System: Demonstration of System Setup at Hunter AAF, GA

by

R.W. Harris
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FOREWORD

This report documents a demonstration conducted for the U.S. Army Engineering and Housing Support Center (USAEHSC) under Facilities Engineering Applications Program (FEAP), Project F58 "Railroad Track Maintenance Management System (RAILER)." The work was conducted by the U.S. Army Construction Engineering Research Laboratory (USACERL), Engineering and Materials Division (EM). The USAEHSC Technical Monitor was Robert Williams, CEHSC-FB-P. His support is greatly appreciated.

The support and cooperation of the personnel at Hunter AAF were crucial to the success of this demonstration: the Facility Engineer (FE), Jerry Bridges, and members of the FE staff including Grady Collet, Albert Myles, and Debbie Sharpe. Assistance in the field and office was provided by J. Borse, D. Brown, F. Calabrese, J. Crowder, and S. Wagers. The USACERL technical editor was D.P. Mann, Information Management Office.

Dr. Paul A. Howdyshell is Acting Chief of USACERL-EM. COL Everett R. Thomas is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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1 INTRODUCTION

Background

The RAILER system of railroad maintenance management is one of a family of Engineered Management Systems (EMS) being developed by the U.S. Army Corps of Engineers to support Army installation Directorates of Engineering and Housing (DEHs) in managing maintenance and repair (M&R) of their facilities. The RAILER system is a decision support tool that can be used, in part, to analyze and evaluate track segments, determine and prioritize work needs, develop annual and long-range work plans, estimate maintenance and repair costs, and develop budgets. The system can help the DEH make maintenance decisions and schedule M&R as needed to meet mission requirements at the least possible cost.

Developed at the U.S. Army Construction Engineering Research Laboratory (USACERL), RAILER includes field procedures for collecting data and a computer program for storing, retrieving, and processing the information to aid maintenance management decisions. While an interim version of RAILER[1] (1.0) had been successfully tested at several sites, the current version (2.0) included several modifications and additional capabilities that had not been demonstrated within a DEH organization. For example, the track inspection procedures[2] had been enhanced to capture all of the track defects specified in the new Army Track Maintenance Standards.[3] The inventory procedures had also been revised as a result of further research and feedback.[4] Another enhancement to RAILER version 2.0 was the development of customized maintenance policies. To support these changes and enhancements, and to provide a more user-friendly interface, the RAILER software had also been greatly revised for version 2.0.

To test the applicability and usability of these new procedures and software, Fort Stewart, GA, was chosen as a demonstration site for RAILER version 2.0.[5] The proximity of Hunter Army Airfield (AAF) and the interaction between the DEH staffs at the two installations made it desirable to include Hunter AAF in the demonstration. This implementation was conducted as part of the FY87 Facilities Engineering Applications Program (FEAP).

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[1] D. R. Uzarski, D. E. Plotkin, and D. G. Brown, *The RAILER System for Maintenance Management of U.S. Army Railroad Networks: RAILER I Description and Use*, Technical Report M-88/18/ADA199859 (U.S. Army Construction Engineering Research Laboratory [USACERL], September 1988).

[2] D.R. Uzarski, D.G. Brown, R.W. Harris, and D.E. Plotkin, *Maintenance Management of U.S. Army Railroad Networks--The RAILER System: Detailed Track Inspection Manual*, Draft Technical Report (USACERL, 1988).

[3] Technical Manual (TM) 5-628, *Railroad Track Standards* (Headquarters, Department of the Army [HQDA], October 1988).

[4] D.R. Uzarski, D.E. Plotkin, and D.G. Brown, *Maintenance Management of the U.S. Army Railroad Networks--The RAILER System: Component Identification and Inventory Procedures*, Technical Report M-88/13/ADA200276 (USACERL, August 1988).

[5] D. G. Brown and D. R. Uzarski, *Maintenance Management of U.S. Army Railroad Networks--The RAILER System: Demonstration of System Setup at Fort Stewart, GA*, Technical Report M-90/22 (USACERL, September 1990).

Objective

The threefold objective of this FEAP demonstration was to:

1. Implement RAILER's data collection procedures and computer program, including recent improvements suggested by experience with the FEAP site at Fort Stewart, GA.[6]

2. Test the ability of the computer software and management procedures to work together in providing maintenance management decision support. In the field, these activities include inventory, inspection, and maintenance policy establishment. On the computer, they include data entry, analysis, and report generation.

3. Establish a working implementation of RAILER version 2.0 to permit an effective, practical evaluation of RAILER by both the prospective users and system developers.

Approach

USACERL personnel fully implemented RAILER version 2.0 at Hunter AAF with assistance of the installation DEH. The Hunter AAF network is fairly small (about 4 track miles total), and so was useful for testing the applicability of RAILER procedures to this size installation. The demonstration followed an approach similar to what a private contractor would probably use for other installations with relatively small track networks. This approach aided USACERL and USAEHSC in developing guidelines for future contract implementations of RAILER at other sites.

During this FEAP, USACERL collected data on RAILER's performance and users' reactions. This feedback was used to improve the system, both during the ongoing implementation and after the FEAP was complete.

Scope

This report describes the implementation and system turnover of RAILER version 2.0 at Hunter AAF. It does not include a history of use by base personnel or support by USACERL.

Mode of Technology Transfer

Interest in RAILER appears to be growing, and several more implementations are currently planned. These efforts will be performed by private contractors or base personnel under the guidance of USAEHSC. In either case, the installation personnel will receive training in RAILER use. USACERL and USAEHSC are jointly developing a standard course. A RAILER support center is also planned for follow-on assistance to installations and maintenance of the RAILER software. The most likely candidate for providing support services would be the extension service of a qualified public university.

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[6] Brown and Uzarski.

2 FIELD WORK

The field work associated with implementing RAILER includes stationing and segmenting the installation railroad network, and collecting data which is later entered into the computer. Stationing establishes a location referencing system for each track in the network. The track segment is the maintenance management unit within RAILER; segmentation is concerned with dividing each track into one or more track segments. Most of the data collection effort is devoted to inventory and inspection data; traffic, installation, work history, and maintenance policy data are also collected. The stationing and segmenting was done on one trip (June 10, 1987). The inventory, installation and traffic information, and part of the inspection data were collected on a second trip (July 13-17, 1987). The inspection was completed and maintenance policy gathered during a third visit (July 25-29, 1988). Work history information was not gathered for this implementation. The system was turned over to installation personnel on a fourth trip (January 19, 1989). The number of trips is due to coordination of this FEAP with the one at Fort Stewart. It is expected that a contractor would make fewer trips, and that each one would be a larger effort. This would keep total hours of effort about the same, but would reduce travel costs.

Procedures for stationing, segmenting, and collecting inventory data are documented elsewhere.[7] as are the detailed inspection procedures implemented.[8] Procedures for collecting other data elements are documented for an earlier version of RAILER.[9] The effective and efficient use of all these procedures requires some office preparation before going to the field.

Office Preparation

Office preparation includes becoming familiar with the track network layout (including identifying all tracks and estimating their lengths), establishing a preliminary track segmentation (and component identification), acquiring and organizing supplies, and developing a work plan to be followed in the field. Table 1 lists the specific tasks and times required for them. While all these functions were performed by engineers, some, such as supply preparation, could be done by technical assistants. All of these activities require information about the installation network. In the case of Hunter AAF, this information was not readily available to USACERL. Information obtained from a Military Traffic Management Command Traffic Engineering Agency (MTMC-TEA) Installation Transportation System Capability Study[10] only provided information for a portion of the track network at Hunter AAF (i.e., the part that would be used in event of mobilization). It was suspected that more track was on base. A trip to Fort Stewart, which is located only about 40 miles from Hunter AAF, was planned. A 1-day information trip was made to Hunter AAF on June 10, 1987 to collect installation maps and verbal information from the Hunter AAF personnel.

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[7] Uzarski, Plotkin, and Brown (August 1988).

[8] Uzarski, Brown, Harris, and Plotkin.

[9] Uzarski, Plotkin, and Brown (September 1988).

[10] *Installation Outloading Capability Study: Fort Stewart, Georgia and Camp Blanding, Florida*, MTMC Report TE 81-3a-42 (Military Traffic Management Command Transportation Engineering Agency [MTMC-TEA], July 1982).

Table 1
Office Preparation Activities and Time Required

Activity	Manhours
Track Segmentation:	
Reviewing Maps	5
Reviewing Segmentation, Curve ID, and Turnout ID assignments	2
Drawing Segmented Track Diagrams	8
Supply Preparation:	
Organizing Station Plates	5
Acquiring and Packing Supplies	3
Reproducing and Packing Data Forms	1
Work Plan Preparation:	
Formulating Plan	4
Communicating with Staff at Meeting (two people)	2
Total	30

Track Segmentation

USACERL personnel segmented the trackage during the June 10, 1987 site visit using the maps provided (Table 2). This information was taken back to USACERL for a continuation of the office preparation before the bulk of the field work was accomplished.

In addition to track segments, two other track components--turnouts and curves--are given identification (ID) numbers within RAILER. These numbers were also assigned during the segmentation process according to established RAILER procedures.[11]

After the network was segmented, track diagrams that included segment, turnout, and curve numbers were made up for use in the field (see Appendix A).

[11] Uzarski, Plotkin, and Brown (August 1988).

Table 2
Hunter AAF Segmentation

Track Number	Number of Segments
1	3
2	3
3	1
4	4
5	2
6	1
7	7
9	2
10	1
5794	5
5807	5

Supplies

The supplies taken to Hunter AAF were based on expected work, network size, and crew size. The equipment required for track inspection is documented elsewhere.[12] Additional equipment included stationing materials (hammer, measuring wheel, nails, and station plates), and equipment for comfort of field personnel (insect repellent, sun screen, gloves, and coolers for food and drinks). A number of RAILER forms are required for data collection; these were taken to Hunter AAF, along with pencils and note paper, with some allowance for wastage. In general, about twice as many forms as needed were taken.

Installing station plates at 200 ft[*] intervals along the track is an important part of RAILER implementation. To make this job easier in the field, the plates were organized by track number in the office before going to the field; each track's station plates were strung in order on a separate wire. Experience at Fort Stewart indicated that this approach saved much time and effort in the field.[13]

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[12] Uzarski, Brown, Harris, and Plotkin.
[*] 1 ft = 0.3048 m.
[13] Brown and Uzarski.

Work Plan

The implementation at Hunter AAF was a small-scale field effort. Most of the field work was done by a crew of two, with some followup by a single person. The planning and scheduling of work was very flexible and informal, as is appropriate for this size project. The actual work is discussed below.

Site Visits

As discussed previously, the field work entailed four site visits to Hunter AAF. Table 3 summarizes the various activities during the visits and the time required for each task.

Table 3
Field Activities and Times

Activity	Manhours
Stationing	16
Track Segment Inventory	24
Track Segment Inspection	40
Traffic	1
Installation Information	1
Maintenance Policy	4
Total	86

As stated earlier, the first visit to Hunter AAF was a 1-day trip, made during a visit to the nearby Fort Stewart, for reconnaissance and segmenting the network. Most of the field data were gathered on the second and third trips. On the third trip, only part of the time was spent gathering field data; the rest was spent at Fort Stewart gathering maintenance policy data that was used for both installations. The fourth visit was a 1-day detour from Fort Stewart to turn the system over to installation personnel.

Most workdays began at 0700 hours and ended at 1730 hours, though some were longer. On the first and second trips, there were two workers. On the third trip there was a single worker. The fourth trip was again made by two workers.

Stationing

The stationing was performed by using a hand-held measuring wheel (Figure 1). A crew of two performed the stationing on the first visit. Station locations were marked at 200 ft intervals on the rail web with paint. The station plates were not available during the first trip, so they were placed during the inventory phase of the second trip. During the stationing process, it is often desirable to note the location

of inventory items, both in a field notebook and by writing locations on the rail web with paint. This was not done at Hunter AAF, and inventory was slowed greatly. During the inventory process, it was necessary to measure the stations of various inventory items, such as culverts and switch points of turnouts. This separate effort during the inventory process takes much longer than stopping to record these locations during stationing. It is recommended strongly that future implementations follow the procedure of noting inventory locations, both on paper and on the rail web, during the segmenting process.

Segmenting

The track segments, identified in the maps provided by Hunter AAF personnel during the first visit, were field validated during the stationing process. No changes were required in the segments or in the turnout and curve identification. The time required to accomplish this field validation is included in the stationing time.

Inventory

Figure 2 is an example of a completed inventory field data form used at Hunter AAF. The inventory data were collected by a two-person crew. The inventory process consists of collecting and recording physical characteristics of the track and related structures that are relatively permanent. These include beginning and end locations, rail weight, tie size and spacing, and many others. Crew members collected this data by walking the track and observing and recording the information. A single pass by a crew of two was sufficient to gather this information, and it was validated by reviewing the inventory notes during breaks and at the day's end.

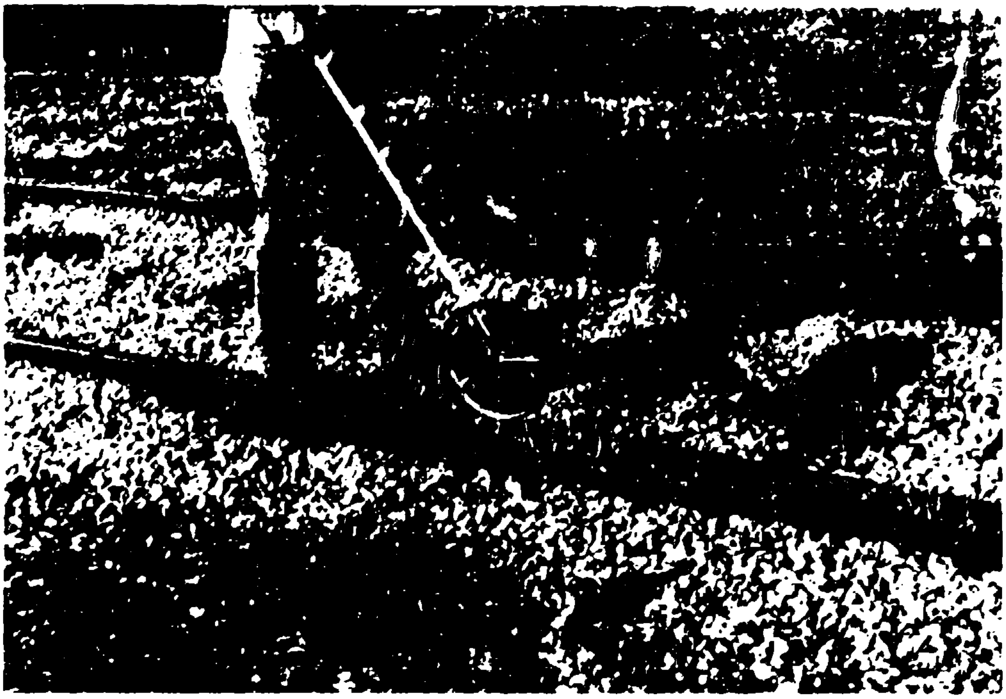

Figure 1. Stationing using hand measuring wheel.

TRACK SEGMENT#: 101 RAILER II DATE: 7/13/87

INSTALLATION NAME: HUNTER AAF TRACK SEGMENT INVENTORY INFORMATION

SEGMENT IDENTIFICATION

Begin Location (station)	End Location (station)	Track Category	Track Use	Track Rank	Construction code	Preceding Track Segment Number (s)	Comments:
0+00	17+99	A B C	Acc Aux L Se St		P S T L	CSX LEAD	

TRACK STRUCTURE

Begin Location (station)	RAIL Weight (lbs/yd)	RAIL Section	TIE PLATE Length (inches)	TIE PLATE Shoulder	RAIL ANCHORS	GAUGE RODS	TIES Cross Section (in x in)	TIES Quantity #/Length	TIES Material Type	BALLAST Support Depth (inches)	BALLAST Type
0+00	85		9	SS DS NS NO	N Y	N Y	6 x 8	123/200	WOOD		STONE
				SS DS NS NO	N Y	N Y					
				SS DS NS NO	N Y	N Y					
				SS DS NS NO	N Y	N Y					

Comments: TIE PLATES ON ABOUT ½ OF SEGMENT

TURNOUTS

Turnout ID Number	Switch Point Location (station)	Direction	Point Length (LF)	Rail Weight Change	Frog Type	Frog Size	Guard Rail Length (LF)	Reversing Tangent <50 ft. Past Frog	Comments:
		LH EQ RH		N Y	B SG RBM SP			N Y	
		LH EQ RH		N Y	B SG RBM SP			N Y	

CURVES

Curve ID Number	Curvature (Degrees) 1	2	3	4	5	6	7	8	Avg.	Super-Elevation (inches)	Max Desired Speed (mph)	Comments:
1C1									6.5			

CROSSINGS

Road Name/ Crossing Identity or Crossing Segment Number	GRADE CROSSINGS Centerline Location (Station)	Road Crossing ID Number	Crossing Length (feet)	Crossing Type	Protection	Bolted Joints	RAIL CROSSING Rail Weight (lbs/yd)	Frog Type	Crossing Angle (degree)
					G F S N	N Y		B MI SM	
					G F S N	N Y		B MI SM	
					G F S N	N Y		B MI SM	
					G F S N	N Y		B MI SM	

Comments:

CLEARANCE RESTRICTIONS AND RELATED FACILITIES

Circle One or Both	Begin Location (Station)	End Location (Station)	Obstruction and/or Facility Type	Restriction Measurement (ft) Horiz.	Vert.	Facility Number	# of Box Car Positions (Docks), or Tangent Track Length (Ramps)	Comments:
CR RF	0+08		D R GATE	7.6				
CR RF			D R					
CR RF			D R					

DRAINAGE STRUCTURES

Centerline Location (Station)	Type	Size (in x in)	Material

Comments:

BRIDGES

Facility Number	Begin Location (Station)	End Location (Station)	Ballasted	Construction Type
			N Y	
			N Y	

Comments:

Figure 2. Completed inventory form.

Inspection

The inspection was done mainly during the second visit, with some final work on the third. After the second visit, the inspection forms were revised for more efficient inspection. These changes were due to experience gained at Fort Stewart[14] and the previous trip to Hunter AAF. Inspection went much faster during the third visit, due to the improved inspection forms. The number of passes to inspect a segment fully was reduced from four or five for a single inspector to two passes for a single inspector, which reduced overall inspection effort by about 50 percent. The speed of passes stayed roughly the same at about 1000 ft/hour (0.2 mph), but still depended on track condition. Only a relatively small part of the Hunter AAF network was inspected using the new procedures, so more verification is needed, but the improvement is clear.

Figures 3 through 12 are completed examples of the inspection forms used at Hunter AAF. Figures 3 through 10 were used during the first part of the inspection effort (second visit); Figures 11 and 12 are the improved forms used during the second inspection effort (third visit).

Traffic Information

Traffic information was obtained from the Installation Transportation Office (ITO) during the third visit to Hunter AAF. The information was gathered through an interview with the ITO director. This information has several potential uses within RAILER, such as prioritizing track segments, structural evaluation, and predicting track deterioration. Only a few car types are used at Hunter AAF, and traffic is quite infrequent. The tracks for the bulk fuel storage yard are occasionally (once every several years) subjected to a trainload of tanker cars (about 150 cars). The other yards tracks see two or three movements a year with lightly loaded cars, rarely with heavy cars. The track to the ordnance area is used only every several years, and handles a load of 20 to 50 box cars when used. Individual car weights were not available. The traffic pattern was made using the data available. The car weights were assumed, somewhat conservatively, to be maximum Gross Vehicle Weight (GVW).

Installation Information

Installation information was obtained from installation personnel and drawings. The nearest commercial yard was the CSX yard in Savannah, GA.

Maintenance Policy Data

A maintenance policy specifies required work actions (if any), and associated costs for those actions, for each defect type/track category combination. Since the DEH at Hunter AAF is subordinate to the Fort Stewart DEH, the policy for Fort Stewart was adopted for Hunter AAF with the approval of Hunter AAF maintenance personnel. The creation of the Fort Stewart policy is documented in the Fort Stewart FEAP report.[15]

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[14] Brown and Uzarski.

[15] Brown and Uzarski.

RAILER II INSPECTION
TIES

DATE: 7/15/87
INSPECTOR: RH

TRACK SEGMENT #	DEFECTIVE TIE CONDITIONS: CONSECUTIVE DEFECTIVE TIES 2	3	4	5 OR MORE	ALL JOINT TIES DEFECTIVE	AVERAGE SPACING PER RAIL LENGTH>22 in.	ROTATED OR SKEWED TIES	MISSING/BUNCHED/BADLY SKEWED TIES (tie spacing along either Rail>48in)	TOTAL DEFECTIVE TIES
101 Check if no defects ☐	𝍸 𝍸 𝍸 ////	𝍸	///	/			𝍸 𝍸 //		
TOTAL	19	5	3	1	0	0	12	0	183
COMMENTS									
102 Check if no defects ☒									
TOTAL									
COMMENTS									
103 Check if no defects ☐	𝍸 𝍸 𝍸 ///	/	//				𝍸 //		
TOTAL	18	1	2	0	0		7	0	163
COMMENTS									

Figure 3. Tie inspection form used during second trip (#1 of 7).

RAILER II INSPECTION
VEGETATION

DATE: 7/15/87
INSPECTOR: JB

TRACK SEGMENT #	DEFECTS	LOCATION * Left Occurrences	Left Total	Center Occurrences	Center Total	Right Occurrences	Right Total
101	No Defects	/	1	卌	5	/	1
	Insufficient, where needed						
	Growing in Ballast	卌 ///	8	////	4	卌 ///	8
	Prevents Track Inspection						
	Interferes with Walking						
	Interferes with Visibility of Signs						
	Brushes Sides of Rolling Stock						
	Interferes with Trains or Track Vehicles						
	Presents a Fire Hazard						
	COMMENTS						
102	No Defects	/	1	/	1	/	1
	Insufficient, where needed						
	Growing in Ballast						
	Prevents Track Inspection						
	Interferes with Walking						
	Interferes with Visibility of Signs						
	Brushes Sides of Rolling Stock						
	Interferes with Trains or Track Vehicles						
	Presents a Fire Hazard						
	COMMENTS						
103	No Defects	卌	5	卌 /	6	卌	5
	Insufficient, where needed						
	Growing in Ballast	////	4	////	4	////	4
	Prevents Track Inspection						
	Interferes with Walking						
	Interferes with Visibility of Signs						
	Brushes Sides of Rolling Stock	/	1			/	1
	Interferes with Trains or Track Vehicles						
	Presents a Fire Hazard						
	COMMENTS						

Figure 4. Vegetation inspection form used during second trip (#2 of 7).

RAILER II INSPECTION
RAIL

INSTALLATION NAME: HUNTER AAF

DATE: 7/15/87
INSPECTOR: RN

TRACK SEGMENT #	DATE	LOCATION (STATION)	RAIL (LEFT OR RIGHT)	DEFECT TYPE	COMMENTS
580701		6+27	L	23	
580701		6+60	L	7	
1101		4+80	L	25	
103		20+00	L	2	
103		40+40	R	23	

RAIL DEFECT TYPES

0 = No Rail Defects in Segment
1 = Bolt Hole Crack
2 = Broken Base
3 = Corroded Base
4 = Complete Break
5 = Crushed Head
6 = Defective Weld
7 = End Batter (>1/4")
8 = Fissure – Compound
9 = Fissure – Transverse
10 = Fracture – Detail
11 = Fracture – Engine Burn
12 = Head/Web Separation
13 = Piped Rail
14 = Split Head – Horizontal
15 = Split Head – Vertical
16 = Split Web
17 = Torch Cut
18 = Wear – Side (>1/2")
19 = Wear – Vertical (>1/2")
20 = Overflow
21 = Shelling
22 = Corrugation
23 = Chip/Dent in Head
24 = Engine Burn
25 = Flaking
26 = Rail Weight Insufficient for Mission
27 = Rail Less Than 13 Feet Long

Figure 5. Rail inspection form used during second trip (#3 of 7).

RAILER II INSPECTION DATE: 7/15/87
TIE PLATE, RAIL FASTENERS AND JOINTS INSPECTOR: RH

TRACK SEGMENT #	COMPONENTS	IMPROPER SIZE/TYPE		FLAMECUT/ ALTERED		MISSING/ INSUFFICIENT NUMBER/ CRACKED/ BROKEN		IMPROPERLY INSTALLED OR LOOSE	
		Occurences	Total	Occurences	Total	Occurences	Total	Occurences	Total
101	Tie Plates !								
Check if no defects	Spikes • !					//	2		450 *
	Joint Bars					/	1		
☐	Joint Bolts					/	1		
	Compromise Bars								
	Rail Anchors • !								
	Gage Rods								
All Joint Bolts Missing or Broken for a Rail End				Occurences	Total	COMMENTS * IMPROPER SPIKE PATTERN IN SCATTERED GROUPS			
Rail End Mismatch Exceeds 3/16"									
Rail End Gap Exceeds 1" but not 2"									
Rail End Gap Exceeds 2"									
102	Tie Plates !								
Check if no defects	Spikes • !								120 *
	Joint Bars								
☐	Joint Bolts								
	Compromise Bars								
	Rail Anchors • !								
	Gage Rods								
All Joint Bolts Missing or Broken for a Rail End				Occurences	Total	COMMENTS * IMPROPER SPIKE PATTERN IN SCATTERED GROUPS			
Rail End Mismatch Exceeds 3/16"									
Rail End Gap Exceeds 1" but not 2"									
Rail End Gap Exceeds 2"									
103	Tie Plates !								
Check if no defects	Spikes • !								970 *
	Joint Bars								
☐	Joint Bolts								
	Compromise Bars								
	Rail Anchors • !								
	Gage Rods								
All Joint Bolts Missing or Broken for a Rail End				Occurences	Total	COMMENTS * IMPROPER SPIKE PATTERN IN SCATTERED GROUPS			
Rail End Mismatch Exceeds 3/16"									
Rail End Gap Exceeds 1" but not 2"									
Rail End Gap Exceeds 2"									

• See reverse for Spiking and Rail Anchor Patterns.

! If defect exists continuously over significant track length, place "X" under "Occurences" and in "COMMENTS" enter the beginning and ending station locations, along with defect type.

Figure 6. Tie plates, rail fastenings and joints inspection form used during second trip (#4 of 7).

RAILER II INSPECTION
ROADWAY AND BALLAST

DATE: 7/15/87
INSPECTOR: [illegible]

TRACK SEGMENT #	ITEM	Hazardous to Train Movement: Occurences	Hazardous to Train Movement: Total	Not Hazardous: Occurences	Not Hazardous: Total
101	Ballast/Subgrade Pumping				
Check if no defects ☐	Insufficient Ballast			//	2
	Erosion of Embankment and Cut Slopes				
	Embankment Sliding or Slippage				
	Potential Slope Stability Problems				
	Settlement at Approaches to Bridges				
	Washouts Under the Track				
Percent of Dirty or Poorly Draining Ballast to Nearest 10%: 30					
COMMENTS:					
	Ballast/Subgrade Pumping				
Check if no defects ☒	Insufficient Ballast				
	Erosion of Embankment and Cut Slopes				
	Embankment Sliding or Slippage				
	Potential Slope Stability Problems				
	Settlement at Approaches to Bridges				
	Washouts Under the Track				
Percent of Dirty or Poorly Draining Ballast to Nearest 10%:					
COMMENTS: BRIDGE					
103	Ballast/Subgrade Pumping				
Check if no defects ☐	Insufficient Ballast				
	Erosion of Embankment and Cut Slopes				
	Embankment Sliding or Slippage				
	Potential Slope Stability Problems				
	Settlement at Approaches to Bridges				
	Washouts Under the Track				
Percent of Dirty or Poorly Draining Ballast to Nearest 10%: 10					
COMMENTS:					

Figure 7. Roadway and ballast inspection form used during second trip (#5 of 7).

RAILER II INSPECTION
ROAD AND RAIL CROSSINGS

DATE: 7/15/87
INSPECTOR: RH

TRACK SEGMENT #	TYPE	ROAD NAME OR CROSSING SEGMENT #	MINIMUM FLANGE WAY		FOULED FLANGE -WAY	OCCURENCES OF RELATED TRACK MATERIAL DEFECTS (RAIL CROSSING ONLY)	SIGNS AND SIGNALS INOPERATIONAL, OBSCURED, OR MISSING	COMMENTS
			DEPTHS	WIDTHS				
901	ROAD RAIL	DOUGLAS	0.1 0.2	2.5 3.0	Y N		Y N	
901	ROAD RAIL	LOADING LANE	1.25 1.25	3.0 3.0	Y N		Y N	
902	ROAD RAIL	LOADING LANE	0.25 1.0	3.0 3.0	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	
	ROAD RAIL		——	——	Y N		Y N	

Includes Improper Size/Type/Position, Chipped/Worn/Bent/Cracked/Broken/Corroded/Altered (including flame out), Loose and Missing

Figure 8. Road and rail crossings inspection form used during second trip (#6 of 7).

RAILER II INSPECTION
DRAINAGE STRUCTURE

DATE: 7/16/87
INSPECTOR: RH

TRACK SEGMENT #	LOCATION (NEAREST 100' STATION)	STRUCTURE TYPE *	STRUCTURE CONDITION	INSUFFICIENT SIZE FOR MAX WATER FLOW	WATER FLOW OBSTRUCTED OR INADEQUATE	HAZARD TO PERSONNEL	COMMENTS
901	4+00	CULVERT	S U	Y N	Y N	Y N	
1102	22+00	CULVERT	S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	
			S U	Y N	Y N	Y N	

* Examples are Culvert, Drain, Storm Sewer, and Drop Inlet

Figure 9. Drainage structures inspection form used during second trip (#7 of 7).

TRACK SEGMENT # ______ RAILER II INSPECTION DATE: 7/16/87
TURNOUT ID # 1T3 TURNOUTS INSPECTOR: RH

GENERAL		TIES	
Rail Weight changes within Turnout limits	N Y	# of Defective Ties in a row (worst case)	2
Reversing Tangent Past Frog Less than 50 Feet	N Y	# of Occurences where Joint Ties are Defective	0
Switch Difficult to Operate	N Y	# of Occurences where Tie Spacing >22 in.	0
Flangeways Dirty or Fouled	N Y	# of Skewed Ties	0
Crib Areas Dirty or Fouled	N Y	# of Missing/Bunched/Badly Skewed Ties (Tie spacing along either rail>48 in.)	0
Line & Surface		TOTAL # of Defective Ties	2

	COMPONENTS	NO DEFECTS	IMPROPER SIZE/ TYPE/POSITION/ DESIGN (Y or #)	LOOSE (Y or #)	CHIPPED/WORN/BENT/ CRACKED/BROKEN/ CORRODED/ALTERED (Y or #)	MISSING (Y or #)
SWITCH & STAND	Switch Stand	X	Y	Y	Y	Y
	Point Lock/Lever Latch	X	Y	Y	Y	Y
	Connecting Rod	X	Y	Y	Y	Y
	Switch Point - Left	X	Y	Y	Y	Y
	Switch Point - Right	X	Y	Y	Y	Y
	Switch Rods				1	
	Rod & Clip Bolts		1			
	Cotter Keys					15
	Slide Plates		1			
	Braces			4		
	Heel Filler & Bolts	X				
	Joint Bars/Shoulder Bars	X				
FROG	Point & Top Surface	X				
	Bolts	X				
GUARD RAILS	Guard Rails	X				
	Filler & Bolts	X				

	MEASUREMENTS (inches)	STRAIGHT SIDE	TURNOUT SIDE
FROG	Gage at Point	56.2	56.8
	Guard Check Gage	54.2	55.0
	Guard Face Gage	52.5	52.9
	Flangeway Width	1.6	2.0
	Flangeway Depth	1.75	1.75
GUARD RAILS	Flangeway Width	2.0	1.8
OTHER	Gage at Switch Points	56.9	
	Gage at Joints in Curved Closure Rails	56.6	

COMMENTS

* See reverse for illustrations of wear and improper position
+ See reverse for illustrations of measurements
See reverse for fraction/decimal conversion table

Figure 10. Turnouts inspection form (same for second and third trips).

RAILER II DETAILED TRACK INSPECTION SHEET 1 OF 2

TRACK SEGMENT #: 702	SEGMENT BEGINNING LOCATION: 8+19	INSPECTOR: RH	DATE: 7/27/88

TIE DEFECTS

CHECK IF NO DEFECTS	INSPECTION IMPAIRED BY VEGETATION OR OTHER MATERIAL	NUMBER OF DEFECTIVE OR MISSING TIES	CONSECUTIVE DEFECTIVE OR MISSING TIES 2	3	4	5 or more	ALL JOINT TIES DEFECTIVE OR MISSING	AVERAGE SPACING PER RAIL LENGTH* >22 in	IMPROPERLY POSITIONED (skewed, rotated, bunched)	TIE CENTER-TO-CENTER DISTANCE ALONG EITHER RAIL > 48"
☐	LENGTH(TF): TOT (TF):		////	//					////	
TOTAL	%: 40	#: 42	#:4	#:2	#:	#:	#	#:	4	#:

COMMENTS:

• 22 inches per tie is equivalent to 21.3 ties per 39 ft. rail and 18 ties per 33 ft. rail

VEGETATION

CHECK IF NO DEFECTS	GROWING IN BALLAST, INTERFERES WITH WALKING, BRUSHES SIDES OF ROLLING STOCK	PREVENTS TRACK INSPECTION, FIRE HAZARD, INTERFERES WITH TRAIN MOVEMENT OR SIGN VISIBILITY	MAKES MOVEMENT VERY HAZARDOUS OR IMPOSSIBLE	COMMENTS:
☐	LENGTH(TF): 3+100	LENGTH(TF):	LENGTH(TF):	
	TOTAL (TF): 103	TOTAL (TF):	TOTAL (TF):	
	%:	%:	%:	

RAIL AND JOINT DEFECTS

DEFECT CODE(s)	RAIL (R,rt both)	SIDE (field, gage, NA)	LOCATION (station)	# OF JOINTS	COMMENTS
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			
	L R B	F G NA			

RAIL DEFECT CODES
- BHC = BOLT HOLE CRACK
- BRC = BREAK - COMPLETE
- BRB = BROKEN BASE
- CDH = CHIP / DENT IN HEAD
- CRB = CORRODED BASE
- COR = CORRUGATION
- CRH = CRUSHED HEAD
- EBD = END BATTER > 1/4"
- EGB = ENGINE BURN
- FLK = FLAKING
- FDT = FRACTURE - DETAIL
- FEB = FRACTURE - ENGINE BURN
- HWS = HEAD / WEB SEPARATION
- OVF = OVERFLOW
- L13 = RAIL LENGTH < 13'
- SHL = SHELLING
- SHH = SPLIT HEAD-HORIZONTAL
- SHV = SPLIT HEAD-VERTICAL
- SWB = SPLIT WEB
- TCE = TORCH CUT END
- TCH = TORCH CUT HOLE
- WRS = WEAR - SIDE
- WRV = WEAR - VERTICAL
- WDD = WELD DEFECT

CHECK IF NO DEFECTS	1/4's	INSPECTION IMPAIRED BY VEGETATION OR OTHER MATERIAL (LF)	LINE TOTAL (LF)	QL (LF)	SUM of QL (LF):
☒	1				TOTAL=SUM QL/4 (TF):
	2				
	3				
	4				%:

JOINT DEFECT CODES
- ABM = ALL BOLTS ON A RAIL END MISSING OR BROKEN
- BJB = BROKEN JOINT BAR (not through center)
- CBB = CENTER BROKEN BAR
- CCB = CENTER CRACKED BAR
- CJB = CRACKED/BENT JOINT BAR (not through center)
- IBP = IMPROPER BOLT PATTERN
- ISB = IMPROPER SIZE/TYPE BAR
- LJB = LOOSE JOINT BAR(s)
- LBT = LOOSE JOINT BOLT(s)
- MBR = MISSING JOINT BAR
- MBT = MISSING/BENT CRACKED or BROKEN BOLT
- RG1 = RAIL END GAP >1" BUT <2"
- RG2 = RAILEND GAP >2"
- REM = RAIL END MISMATCH >3/16"

Figure 11. Project Level Track inspection form used during third trip (#1 of 2).

RAILER II PROJECT LEVEL TRACK INSPECTION SHEET 2 OF 2

TRACK SEGMENT #: 702	SEGMENT BEGINNING LOCATION: 8+19	INSPECTOR: RH	DATE: 7/27/88

OTHER TRACK COMPONENT DEFECTS

COMPONENT CODE	DEFECT CODE	LOCATION (station)	LENGTH (TF)	DENSITY (%)	QTY (#)	IMMEDIATE HAZARD	COMMENTS
TP	IS	8+19	60	10		N Y	INCORRECT UNDER JOINTS
SP	IP	8+19	60	10		N Y	IN ANGLE BAR SLOTS
SP	IP	8+19	730	25		N Y	INCORRECT PATTERN
RC	FD	9+80				N Y	FOULED
TP	MI	10+50			2	N Y	
TP	MI	11+00				N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
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						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	
						N Y	

1/4's	INSPECTION IMPAIRED BY VEGETATION OR OTHER MATERIAL (LF)	LINE TOTAL (LF)	Q.L. (LF)
1	15	15	
2	20+12	32	
3			
4	100	100	
SUM QL (LF):		TOTAL (TF)	
QL/4(TF):			

COMPONENT CODES

BS = BALLAST / SUBGRADE
BA = BRIDGE APPROACH
CU = CULVERT
DR = DRAIN
EM = EMBANKMENT
GR = GAGE ROD(s)
RA = RAIL ANCHOR(s)
RR = RAIL CROSSING
RC = ROAD CROSSING
SS = SIGNS / SIGNALS
SP = SPIKE(s)
SW = STORM SEWER
TP = TIE PLATE(s)
OT = OTHER

DEFECT CODES

BR = BROKEN
CR = CRACKED/BENT
BD = BALLAST - DIRTY
ER = EROSION
FF = FLANGEWAY - FOULED
FD = FLANGEWAY - DEPTH
(rail crossings) MIN <1 6/8"
(road crossings) MIN <2 1/2"
IP = IMPROPER POSITION
IS = IMPROPER SIZE/TYPE
IA = INSUFFICIENT AMOUNT
LO = LOOSE
MI = MISSING
NF = NON - FUNCTIONAL
NV = NON - VEGETATIVE MATERIAL INTERFERING WITH TRACK INSPECTION
OF = OBSTRUCTED FLOW
PU = PUMPING
SE = SETTLEMENT
SL = SLOPE STABILITY
SD = STRUCTURAL DETERIORATION
TC = TORCH CUT/ALTERED
WA = WASHOUT

Figure 12. Project level track inspection form used during third trip (#2 of 2).

3 DATA LOADING AND PROCESSING

The data loading and processing required several steps. First, all data collected at Hunter AAF was entered into the computer. Then RAILER information reports were run to check against the original field forms for missing/erroneous data. After the information was verified and errors corrected, the reports were run again. Some of these reports are presented in Appendix B. The computer work was done on an IBM-PC AT with a 20 M hard disk. The data was entered and verified by an engineer, but it could have been done by a trained technical assistant or data entry specialist.

Data Entry

The database for Hunter AAF was created using an option in the RAILER program. The data was then transferred from the paper forms to the computer using the RAILER data entry procedures. Because the program continued to evolve throughout the time data was collected, the data entry screens did not always match the original data collection forms. In particular, because of changes made to the inspection procedures between the second and third site visits the data collected during the first visit was in a much different format from the program screens. To help make the information easier to enter, the data on the old forms was translated onto the new forms before entry into the computer. This extra step greatly eased the burden of the data entry person. Since future implementations will not require this task, the time required for inspection data entry should drop by 20 to 50 percent. The data entry speed for Hunter AAF was similar to that of Fort Stewart. Table 4 contains the data entry time for Hunter AAF.

Table 4
Data Entry and Verification Times

Note: Approximately 50% of time was for data entry, 50% for verification

Information Area	Workhours
Installation Information	1
Track Segment Inventory	14
Track Segment Inspection	16
Maintenance Policy (used Fort Stewart's)	1
Traffic	1
Total	33

Data Verification and Processing

After the data was loaded, the following RAILER information reports were run:

- Installation Network Information
- Track Segment Inventory Information
- Track Segment Inspection Information
- Traffic Information Report
- Policy Report.

These reports were compared with the data collection form to check for errors in the data entry. Some mistakes made in the field were detected in this phase as well, usually, minor oversights such as a tie count of 212 ties per 200 ft, instead of 112 ties per 200 ft. After the corrections were made, the reports were run again and verified. Estimating the time for this procedure is difficult because, in this effort, the data correction phase was combined with the system development task of checking and verifying RAILER algorithms. The Fort Stewart FEAP test reported a time of 3 hours.[16] A reasonable estimate for the time required for checking and verifying the Hunter AAF database would probably be 1 to 3 hours.

When the database was correct, key reports were generated (Appendix B). The installation information and segment inventory information reports describe the relatively permanent features of the track network. The inspection condition comparison compares the current inspection to the U.S. Army track standards,[17] providing a fairly objective assessment of track condition and operational status of each track segment. The condition comparison report has three different levels of detail. The comparison in Appendix B is at the middle level of detail (comparison by inspection type).

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[16] Brown and Uzarski.

[17] Technical Manual (TM) 5-628, *Railroad Track Standards* (Headquarters, Department of the Army [HQDA], October 1988).

4 SYSTEM TURNOVER TO INSTALLATION PERSONNEL

There are three main objectives to system turnover: (1) to install a working copy of RAILER and the installation database onto the computer that will be used for running RAILER, (2) to show installation personnel what has been done in the implementation process and how it will benefit them, and (3) to train the personnel who will be using the system.

The system turnover at Hunter AAF was somewhat challenging in that extensive personnel reorganization took place at Hunter AAF during the course of the FEAP. Personnel left and arrived, and many changed job functions. When the USACERL team arrived to turn over the database, personnel at Hunter AAF were still in a period of adjustment and it was unclear who would be responsible for RAILER's use at the installation. The most likely users had not yet been informed about RAILER or the work that USACERL personnel had done.

However, when the responsible individuals were identified, the installation personnel were very cooperative and the turnover was successful. Meetings were held with the facility engineer, Jerry Bridges; the track foreman, Grady Collet; and the computer programmer, Debbie Sharpe. RAILER was installed on a computer in the office, and personnel were briefed on the RAILER program and its usefulness. Informal instruction was provided on system use; formal training for installation personnel is being planned, probably through the extension services of a qualified public university. Overall, the people who were briefed and instructed were interested in RAILER and showed a desire to make it function well and provide long-term benefits.

While it is not within the scope of this report to document the long-term use of RAILER at Hunter AAF, it is expected that the long-term success of the project will require support for the installation personnel. This support is being planned through a support center and/or a RAILER users' group.

5 CONCLUSIONS AND RECOMMENDATIONS

RAILER version 2.0 was implemented successfully at Hunter AAF as part of the FY88 FEAP. Installation personnel were interested in the system and wished to make the project a long-term success as well.

The data collection process was demonstrated, including segment inventory and track inspection. New track inspection procedures were verified to be improvements over those used at Fort Stewart and in the early phases of collection at Hunter AAF. The structured inspection procedures eased the burden on the inspectors' memory, leaving them more time to concentrate on spotting defects. The procedures are quite good for project-level type inspection, but are still too labor-intensive for network-level management. The network-level procedures being developed at USACERL are aimed at reducing the effort needed to evaluate the track. Less detail and the addition of sampling techniques should reduce the required time without sacrificing safety. The project-level inspections would then be performed only on those segments scheduled for maintenance in the near future.

A crew size of one or two was sufficient to perform the procedures. A third member increases efficiency in some procedures, but is probably not justified for an installation of this size. The stationing and inventory can both be accomplished in a single pass by two crew members. The inspection can be completed in a single pass by two crew members as well, though they may choose to use more than one pass in some situations, such as when the track is in very poor condition and inspection effort per foot of track rises. The other tasks, such as gathering installation network, traffic, and policy information, can be gathered by a single person working with installation personnel and/or installation records. If two crew members are on site, the best allocation of resources is probably to divide the tasks and have each crew member gather information separately.

The implementation at Hunter AAF complemented the implementation at Fort Stewart and showed that RAILER is workable. As a result of these experiences, it is recommended that RAILER version 2.0 be released for general implementation on domestic Army installations. It is also recommended that the applicability of RAILER version 2.0 to other potential users be investigated.

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Brown, D. G. and D. R. Uzarski, *Maintenance Management of U.S. Army Railroad Networks--The RAILER System: Demonstration of System Setup at Fort Stewart, GA*, Technical Report M-90/22 (USACERL, 1990).

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Uzarski, D. R., D. E. Plotkin, and D. G. Brown. *The RAILER System for Maintenance Management of U.S. Army Railroad Networks: RAILER I Description and Use*, Technical Report M-88/18/ADA199859 (USACERL, September 1988).

Uzarski, D. R., D. G. Brown, R. W. Harris, and D. E. Plotkin, *Maintenance Management of U.S. Army Railroad Networks--The RAILER System: Detailed Track Inspection Manual*, Draft Technical Report (USACERL, 1988).

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APPENDIX A:
Final Segmented Maps

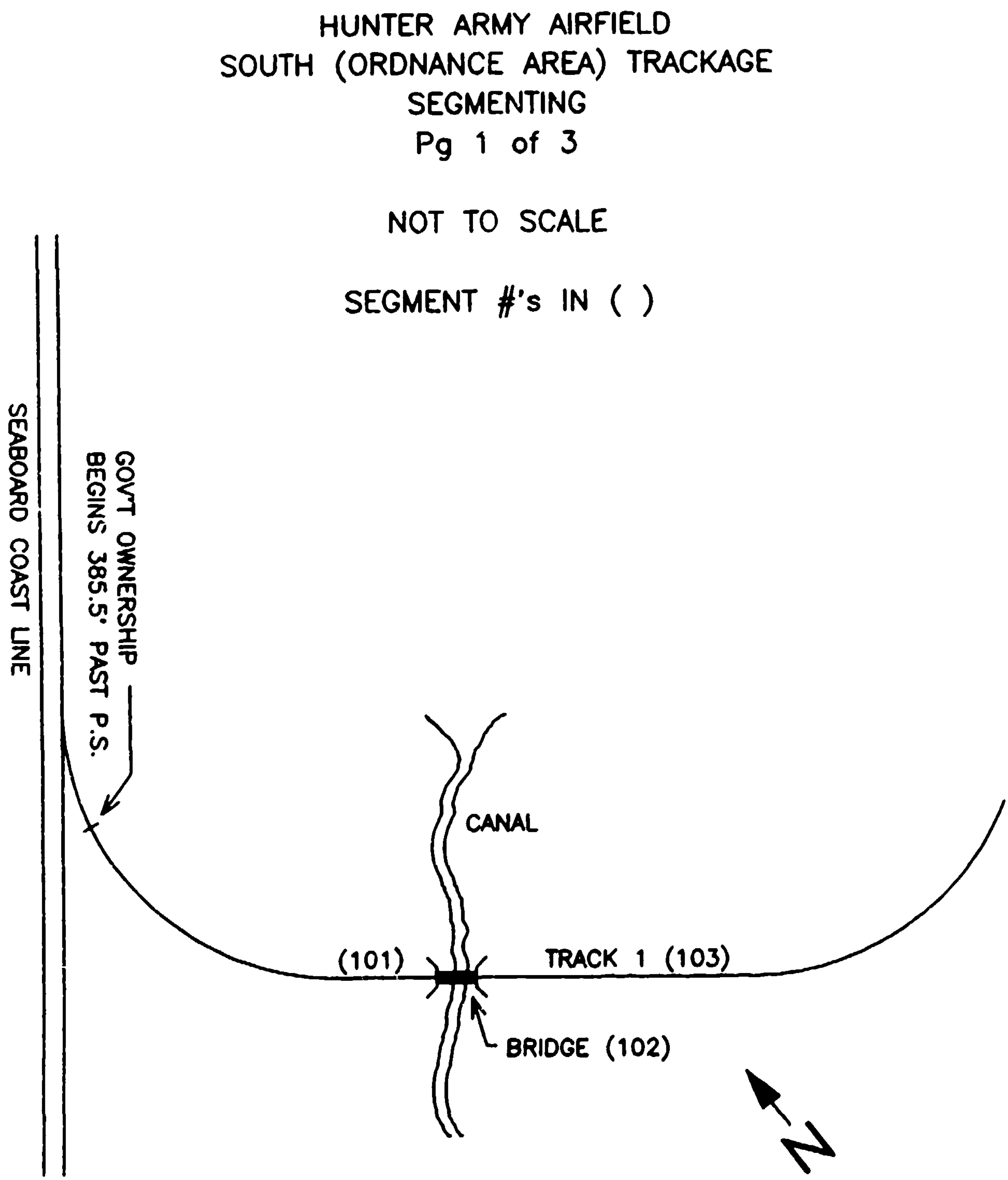

Figure A1. Hunter Army Airfield South (Ordnance Area) Trackage Segmenting.

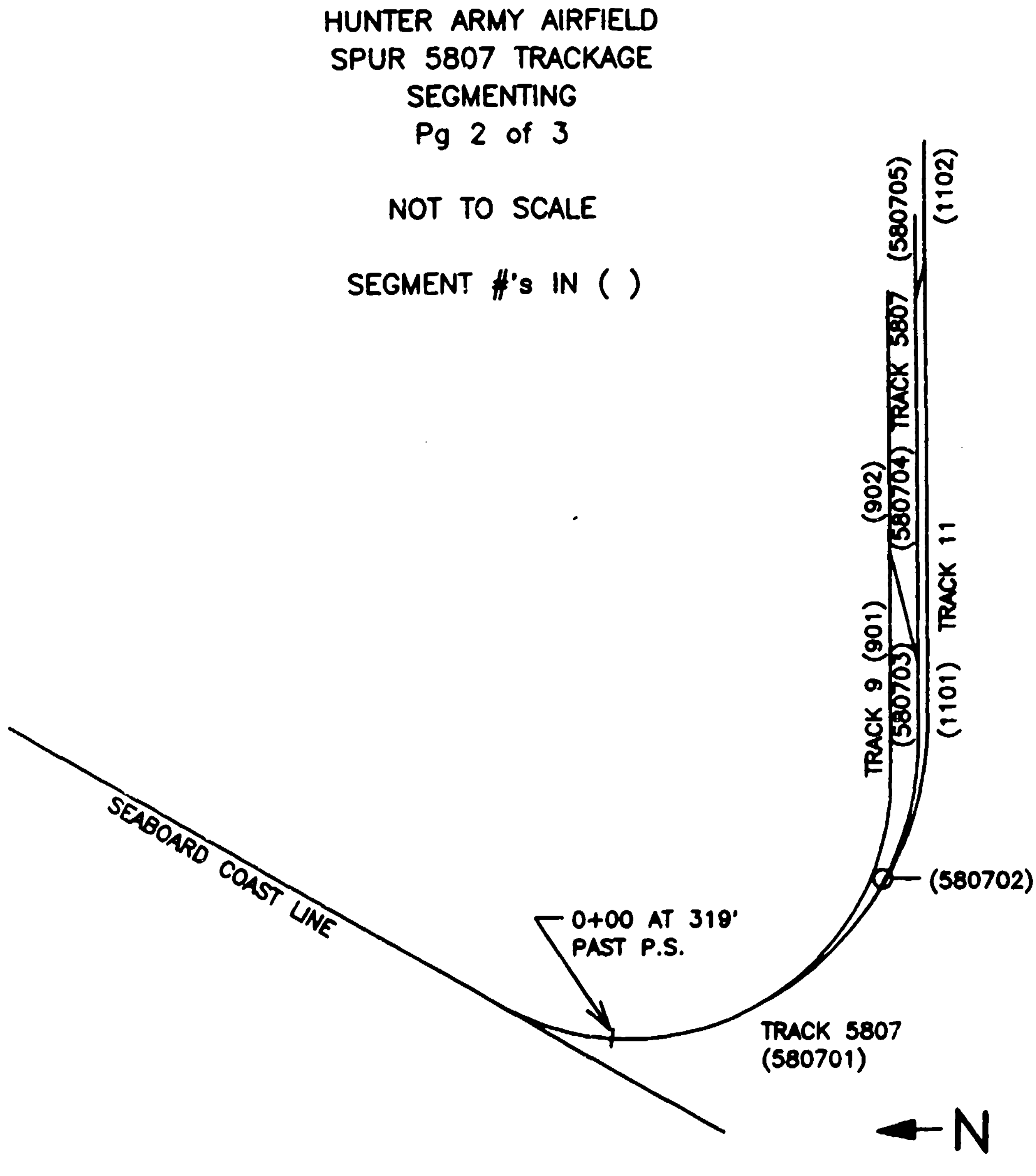

Figure A2. Hunter Army Airfield SPUR 5807 Trackage Segmenting.

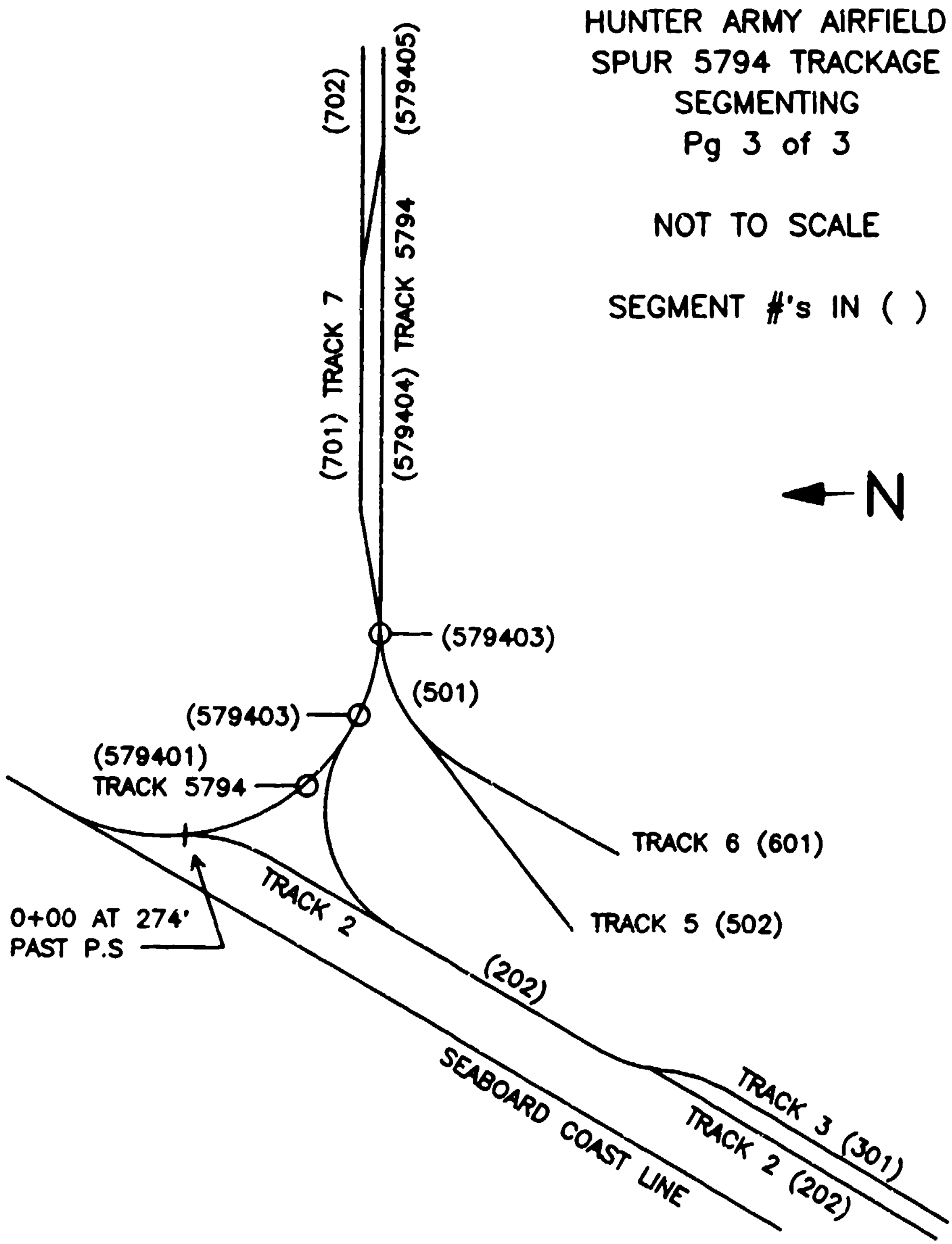

Figure A3. Hunter Army Airfield SPUR 5794 Trackage Segmenting.

APPENDIX B: RAILER Reports

HUNTER, GA — RAILER — Page: 1

05/17/1989

TRACK SEGMENT INVENTORY INFORMATION REPORT

INSTALLATION #: 00000 — PRIMARY INSTALLATION NUMBER:

SEGMENT IDENTIFICATION

Track Segment #	Begin/End Location (station)	Track length (feet)	Track Category	Track Use	Track Rank	Construction Code/ Preceding Track Segment #(s)
901	0+88 11+26	1038	B	LOADING		P 580701

Comments:

TRACK STRUCTURE

RAIL

Track Segment #	Begin Location (station)	End Location (station)	length (feet)	Weight (lbs/yd)	Section
901	0+88	1+26	2076	85	

	FASTENINGS			TIES			BALLAST	
Tie Plate Length (in)	Shoulder	Rail Anchors	Gauge Rods	Cross Section (in x in)	Spacing (in)	Material	Support Depth (in)	Type
9.00	SS	Y	Y	6X8	20.51	WOOD		CRUSHED STONE

Comments:

CURVES

Track Segment #	Curve ID #	Curvature (degrees)	Required Superelevation (inches)	Speed (mph)
901	1C9	16.10	0.00	

Comments:

Track Segment #/ Road Name or Crossing Identity	Centerline Location (station)	Road Crossing ID #	Crossing Length (feet)	Crossing Type	Protection	Bolted Joints
901	4+51	30.0	AC	SIGNS	Y	
DOUGLAS						
Comments:						
901	6+56	20.0	AC	NONE	Y	
LOADING LANE						
Comments:						

CLEARANCE RESTRICTIONS AND RELATED FACILITIES

Track Segment #/ Type	Begin/End Location (station)	Obstruction and/or Facility Type	Restriction Measurement (feet) Horiz (Center)	Vert	Facility Number	# of Box Car Positions For Docks or Tangent Track Lengths For Ramps
901	5+80	DOCK	7.30			
BOTH	10+46					

Comments: Measurement from inside of near rail head

DRAINAGE STRUCTURES

Track Segment #	Centerline Location	Type	Size (inches)	Material
901	4+51	PIPE	24	CONCRETE
Comments:				
901	6+87	PIPE	12	METAL
Comments:				
901	8+86	PIPE	12	METAL
Comments:				

RAILER
Condition Comparison
by Inspection Type Report

Report Criteria: Condition Comparison by Inspection Type Report for Track Segment(s): 901, 902.

TRACK SEGMENT #	NO OPERATION	5 MP SPEED LIMIT	10 MPH SPEED LIMIT	FULL COMPLIANCE	DEFECT FREE
901					
		TIES		FLANGEWAY MEA	RAIL & JOINTS
				TRACK COMP	
				VEGETATION	
902				FLANGEWAY MEA	RAIL & JOINTS
				TIES	VEGETATION
				TRACK COMP	
				TURNOUT GEOM	
				TURNOUTS	

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